Band-Pass Filter Design by Segmentation in Frequency Domain for Detection of Epithelial Cells in Endomicroscope Images

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Introduction

- Change of the mucus of the vocal folds can be the reason for voice hoarseness [1].
- This epithelium can be examined with micro endoscopes, see sample image in Figure 1(a).
- Due to the bad image quality, cell detection is a difficult task.
- In Fourier domain an ellipse is visible which represents the repeating pattern of the cell walls [2,3], see Figure 1(b).
- Previously, this ellipse was segmented manually [4].
- In this work, a new automatic band-pass filter design is introduced to segment this ellipse in order to improve image quality.

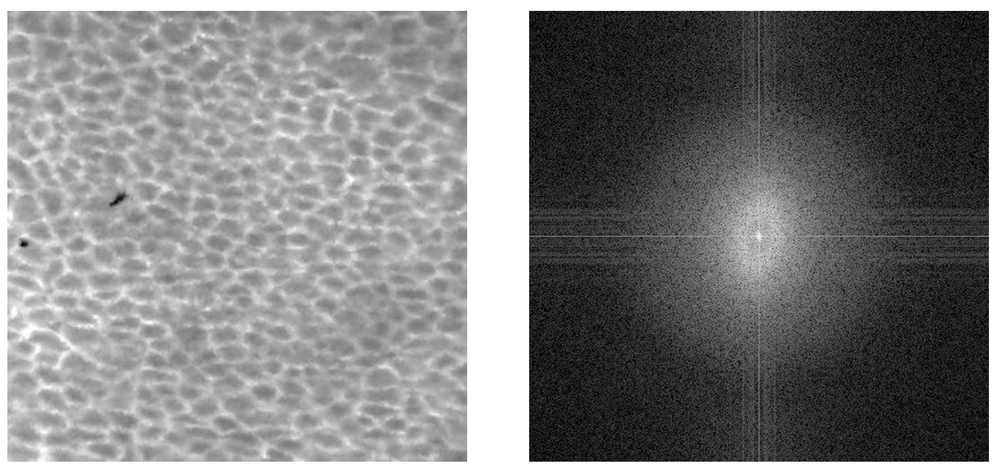

Figure 1
(a) Epithelial cell image of the vocal fold mucus.
(b) Fourier transform of cell image.

Materials and Methods

- The workflow of two different methods is shown in Figure 2.
- Threshold is selected such that 98.8 % of the pixel values in the Fourier image is below the threshold.
- Cut out low frequencies and multiply binary mask on Fourier image and do the inverse Fourier transformation.

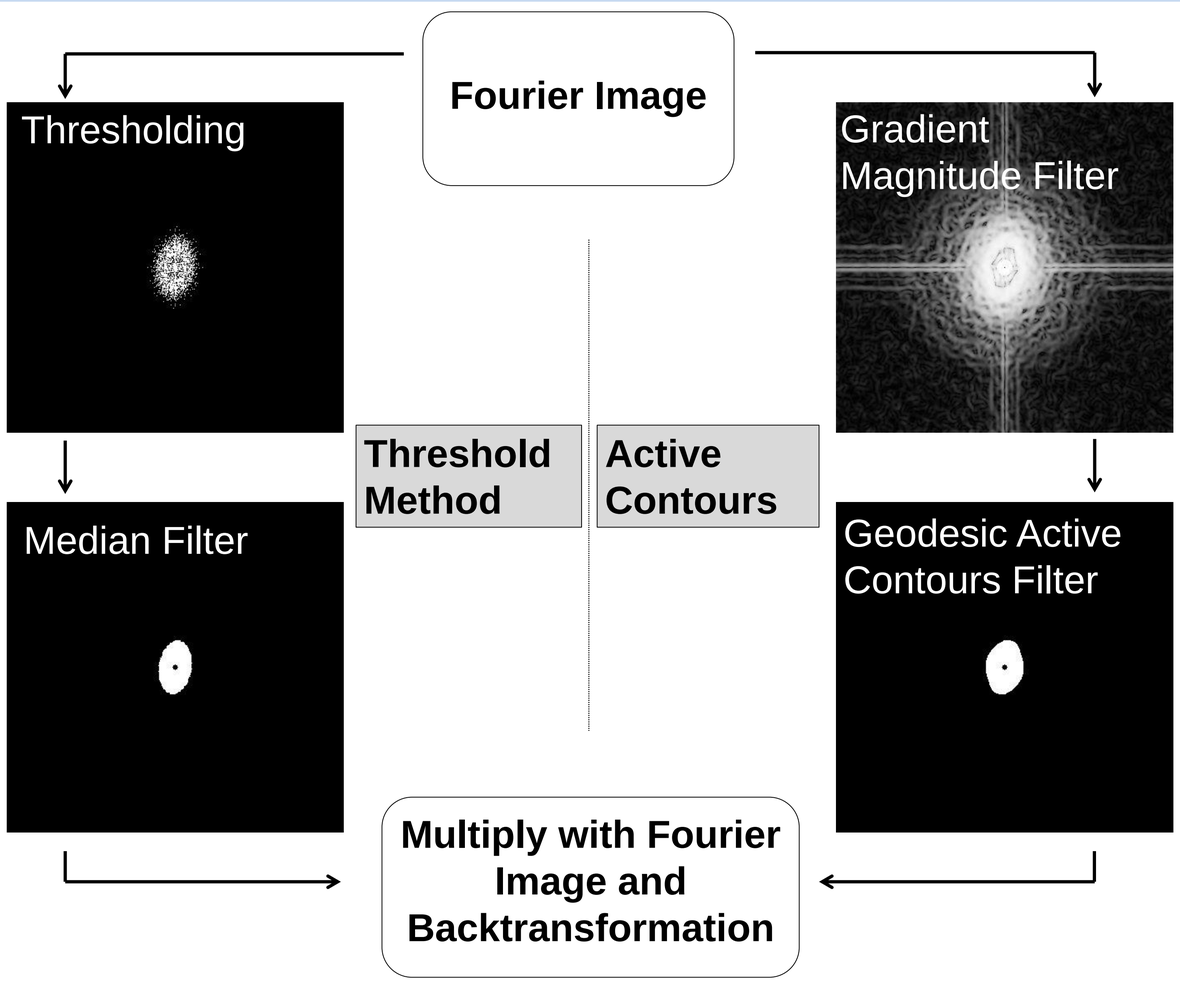

Figure 2
Method Workflows: left side shows the thresholding and the right side the active contour approach.

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Results and Discussion

- Reference data obtained by manually labeling of the cells in the original images.
- Cell detection is done by detecting the intensity minima in the filtered image.
- Cell matching is done with the Hungarian algorithm.
- The new methods achieve almost the same results (see F-measure in Table 1).
- New methods superior to the manual segmentation method[4] regarding to the F-measure.
- Cell walls remain in the filtered image, thus a more robust cell detection is possible, see Figure 3.

	Recall	Precision	F-measure
Original Image	82.2 ± 0.9	24.3 ± 4.0	38.8 ± 5.1
Manual [4]	94.6 ± 3.7	70.0 ± 7.3	80.2 ± 4.7
Thresholding	83.6 ± 2.2	83.9 ± 3.3	**83.7 ± 2.0**
Geodesic	83.5 ± 5.1	83.1 ± 4.1	**83.3 ± 4.1**

Table 1: Results shown for cell detection on the original, the manually processed and the images processed with the new developed methods.

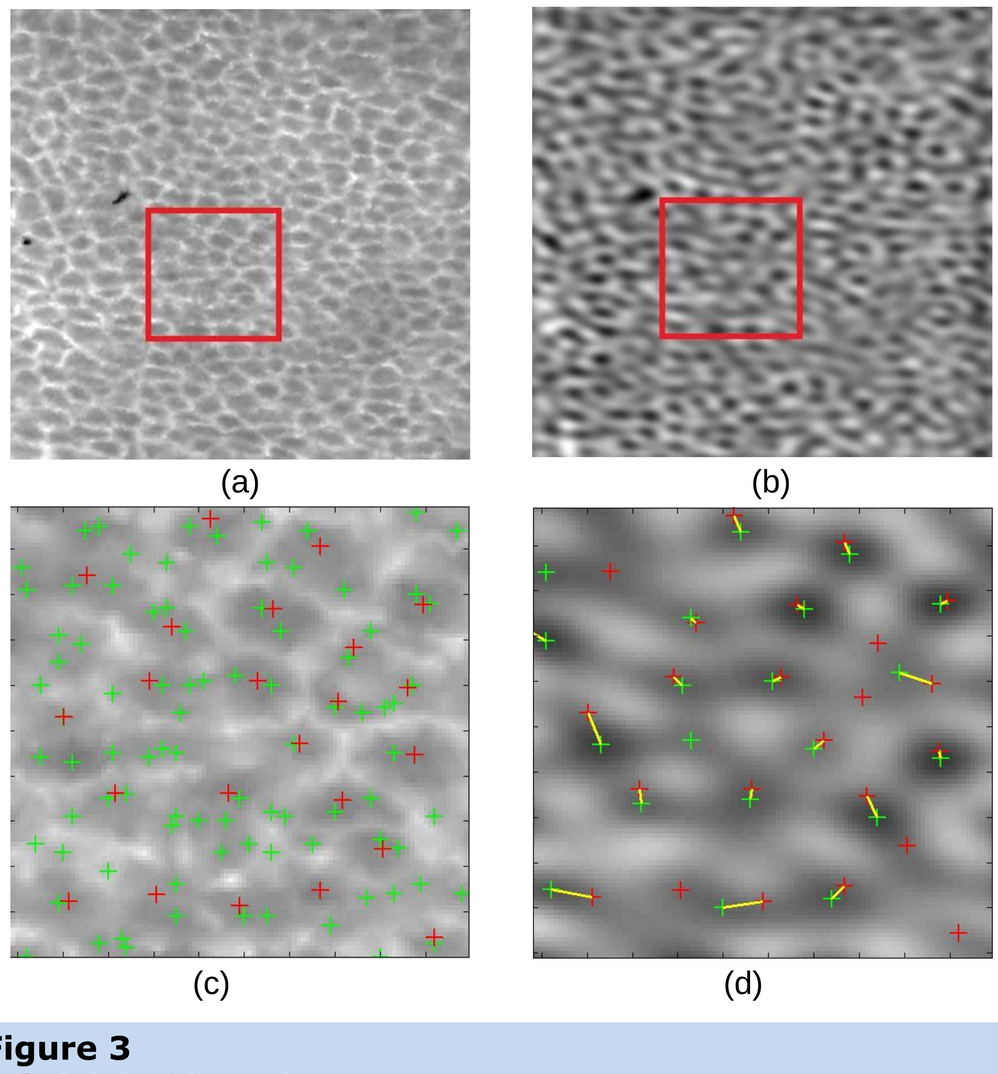

Figure 3
(a) Original input image.
(b) Sample reconstruction result.
(c)+(d) Zoomed regions of the upper images with reference (red) and automatic detected (green) cells marked. Yellow lines in the right image mark matched cells.

Conclusions

- It was shown that an automatic segmentation of an ellipse in the Fourier domain is possible.
- The results of cell detection showed that the new methods are superior to the manual segmentation[4].

References

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